

# **Executive Summary**

## **Yakima River Basin Storage Alternatives**

### **Appraisal Assessment**

#### **Background**

Congress, in the Act of February 20, 2003, directed the Secretary of the Interior, acting through the Bureau of Reclamation, to conduct a feasibility study of options for additional water storage for the Yakima River basin. Reclamation initiated the Yakima River Basin Water Storage Feasibility Study (Storage Study) in May 2003. Funding has been provided to Reclamation for Storage Study activities under a Memorandum of Agreement for Cost Sharing entered into with the Washington State Department of Ecology (Ecology) on November 14, 2003, and by congressional appropriations.

Due to the congressional authorization, Reclamation initially placed priority on study activities related to the Black Rock Alternative. Reclamation released the *Appraisal Assessment of the Black Rock Alternative (Black Rock Appraisal Assessment)* in February 2005. In that *Black Rock Appraisal Assessment*, Reclamation concluded that, based on current information, a potential Black Rock Alternative appears to be technically viable and could meet the goals of the Storage Study. Therefore, Reclamation decided to carry the Black Rock Alternative forward into the Plan Formulation Phase.

This *Yakima River Basin Storage Alternatives Appraisal Assessment (Yakima Alternatives Appraisal Assessment)* analyzes the technical viability and capability of three in-basin storage alternatives—Bumping Lake enlargement, Wymer dam and reservoir, and Keechelus-to-Kachess pipeline—to meet the storage study goals. Reclamation used the analysis in this document to decide which, if any, of the three Yakima River basin storage alternative(s) to bring forward into the Plan Formulation Phase of the Storage Study along with the Black Rock Alternative. The objective of plan formulation is to define the most viable storage alternative for the feasibility report/environmental impact statement (FR/EIS). Reclamation and the Secretary of the Interior will use the FR/EIS to decide whether to seek congressional authorization for construction of a viable Storage Study alternative. Reclamation expects to complete the FR/EIS by the end of 2008.

### Purpose and Need

The purpose of the Yakima River Basin Water Storage Feasibility Study is to evaluate alternatives that would create additional water storage for the Yakima River basin and assess their potential to supply the water needed for ecosystem aquatic habitat, basinwide agriculture, and municipal demands.

The need for the study is based on the existing finite water supply and limited storage capability of the Yakima River basin in low water years. This finite supply and limited storage capacity does not meet the water supply demands in all years and results in significant adverse impact to the Yakima River basin's economy, which is agriculture-based, and to the basin's aquatic habitat, specifically, anadromous fisheries. Reclamation seeks to identify means of increasing water supplies available for purposes of improving anadromous fish habitat and meeting irrigation and municipal needs.

### Goals

This *Yakima Alternatives Appraisal Assessment* is a component of the Storage Study. Reclamation prepared this report to address the technical viability of the three Yakima River basin storage alternatives and the extent the additional stored water supply provided by these alternatives would assist in meeting the Storage Study goals.

The Storage Study goals are to:

- Improve anadromous fish habitat.
- Improve the water supply for proratable irrigation water rights.
- Meet future municipal water supply.

### Yakima Basin Storage Alternatives

Reclamation is considering three Yakima River basin storage alternatives: a new Bumping Lake Dam and enlarged reservoir, Wymer dam and reservoir, and Keechelus-to-Kachess pipeline.

To assess technical viability of these alternatives, Reclamation used prior Yakima River basin water resource reports and supporting technical documents (relating primarily to engineering, geologic, and seismotectonic information) to set the physical parameters of the alternatives.

## Features

A new Bumping Lake Dam and enlarged reservoir would be constructed on the Bumping River, approximately 4,500 feet downstream of the present dam. The enlarged reservoir would include up to 458,000 acre-feet of storage capacity (about 424,300 acre-feet additional storage and 33,700 acre-feet replacement storage for the existing Bumping Lake).

A new Wymer dam, dike, and reservoir would be constructed on Lmuma Creek, about 1½ mile upstream of its confluence with the Yakima River. The 174,000-acre-foot-capacity Wymer reservoir would be filled by a new 400 cfs-pumping plant operating when Yakima River flows are available and not required for downstream needs (primarily in the winter and spring).

Table ES-1 shows the physical features of the potential Bumping Lake enlargement and Wymer dam, dike, and reservoir, and pumping plant.

**Table ES-1. Bumping Lake Enlargement and Wymer Dam, Dike, Pumping Plant, and Reservoir Characteristics**

Item	Data		
	Bumping Lake Enlargement	Wymer	
		Dam	Dike
Dam			
Type	Zoned rockfill	Concrete-faced rockfill	
Height	230 feet	415 feet	130 feet
Crest elevation	3580 feet	1745 feet	1745 feet
Crest length	3300 feet	2,855 feet	2,310 feet
Crest width	30 feet	30 feet	30 feet
Reservoir			
Active capacity	458,000 acre-feet*	174,000 acre-feet	
Pumping Plant			
Capacity		400 cfs	
Total head range		345 to 475 feet	
*consists of 424,300 acre-feet new storage and 33,700 acre-feet replacement storage for existing Bumping Lake.			

The concept of a Keechelus-to-Kachess pipeline alternative is to transport Keechelus Lake watershed runoff which, at times, exceeds the capacity of Keechelus Lake, for storage in Kachess Lake. The conceptual plan is to modify the outlet works of Keechelus Dam to permit releases to a potential gravity-flow pipeline extending approximately 5 miles to Kachess Lake, as well as maintain current releases to the Yakima River. This potential pipeline, 5 feet in diameter, would start at the outlet works and cross under Interstate Highway 90 to Kachess

Lake. The maximum carrying capacity of the pipeline would be 210 cfs when Keechelus Lake is at full pool.

### Project Costs

Reclamation developed appraisal-level field construction costs for each of the three storage alternatives by indexing the mid-1980s Yakima River Basin Water Enhancement Project storage investigations costs to July 2004 prices.<sup>1</sup> The mid-1980s appraisal-level field construction costs were based on available, but limited, field data and preliminary designs and drawings, and professional assumptions.

Estimated appraisal-level field construction and total project costs, indexed to July 2004 prices, are shown in Table ES-2. The total estimated field costs are:

- Bumping Lake enlargement - \$210 million.
- Wymer dam and reservoir - \$280 million.
- Keechelus-to-Kachess pipeline - \$18.5 million.

The total estimated field costs for all three Yakima River basin storage alternatives combined is approximately \$508.5 million.

The costs for preparing final engineering designs and specifications, land acquisition, regulatory compliance and permitting activities, environmental mitigation and monitoring, and construction contract administration and management are estimated to be from 20 to 35 percent of the field construction costs. Based on the indexed appraisal-level field construction cost estimates and industrywide, accepted cost estimating methodology, standards, and practices, the total project cost estimates for all three alternatives combined range from \$612 million to \$685 million, at July 2004 price levels.

The ranges of total project costs for individual alternatives are as follows (at July 2004 price levels):

- Bumping Lake enlargement - \$250 million to \$280 million.
- Wymer dam and reservoir - \$340 million to \$380 million.
- Keechelus-to-Kachess pipeline - \$22 million to \$25 million.

---

<sup>1</sup> The Black Rock Alternative field construction cost estimates are based on June 2004 price levels. However, Bureau of Reclamation Cost Trends are reported on a quarterly basis (January, April, July, and October), so July 2004 was used, as a close approximation of June 2004 prices.

These costs are for comparison purposes only. It is highly probable that these cost estimates will increase with more detailed analysis and the application of 2006 or later unit prices for materials, labor, and equipment.

**Table ES-2. Appraisal-Level Project Costs for the Yakima Basin Storage Alternatives (July 2004)\***

	<b>Bumping Lake Enlargement</b>	<b>Wymer Dam, Reservoir, and Pumping Plant</b>	<b>Keechelus-to- Kachess Pipeline</b>
<b>Construction Pay Items (indexed to June 2004)</b>	\$139,881,060	\$187,524,675	\$12,146,845
<b>Total mobilization costs (5%)</b>	\$7,000,000	\$9,400,000	\$610,000
<b>Total unlisted Items (15%)</b>	\$23,188,940	\$33,075,325	\$1,913,527
<b>Construction Contract Cost</b>	\$170,000,000	\$230,000,000	\$14,500,000
<b>Total Contingencies (25%)</b>	\$40,000,000	\$50,000,000	\$4,000,000
<b>Total Field Construction Cost</b>	\$210,000,000	\$280,000,000	\$18,500,000
<b>Non-Contract Cost (35%)</b>	\$70,000,000	\$100,000,000	\$6,500,000
<b>Total Project Cost (rounded)</b>	\$280,000,000	\$380,000,000	\$25,000,000
* The Black Rock Alternative field construction cost estimates are based on June 2004 price levels. However, Bureau of Reclamation Cost Trends are reported on a quarterly basis (January, April, July, and October), so July 2004 was used, as a close approximation of June 2004 prices.			

## Operations

Reclamation operates the Yakima Project to meet the purposes of irrigation water supply, instream flows for fish, flood control, hydroelectric generation, and recreation. Reclamation combined the three alternatives in one integrated operation scenario for this *Yakima Alternatives Appraisal Assessment*.

The Yakima RiverWare (Yak-RW) model, a daily time-step hydrologic model simulating reservoir and river operations, was used in conducting operation studies for this *Yakima Alternatives Appraisal Assessment*. The 23-year period-

of-record (1981-2003) used in the model includes 17 nonproration water years (wet and average water supply conditions) and 6 proration years (dry water supply conditions).

The *Yakima Alternatives Appraisal Assessment* contains three operation scenarios:

- Current Operation Scenario – Simulates present Yakima Project operations over the 23-year period of hydrologic record.
- Integrated Operation Scenario – Combines all three Yakima River basin storage alternatives together, plus the existing Yakima Project facilities. The enlarged Bumping Lake was operated to improve the dry-year irrigation water supply available for proratable entitlements. In the RiverWare model, Wymer reservoir was operated to meet Public Law 103-434, *Title XII, Yakima River Basin Water Enhancement Project* (Title XII) target flows at the Parker gauge whenever stored water releases are necessary in dry years, in lieu of releasing water from upstream reservoirs. This operation permits retention of stored water in the Yakima Project reservoirs to improve the dry-year water supply available for all Yakima River basin proratable water rights. The Keechelus-to-Kachess pipeline was used to move water in an attempt to increase reservoir storage in Kachess.

The integrated operation scenario includes three operation studies in which different thresholds (100 percent, 70 percent, and 50 percent) are used in prorated water years for allocating the additional water supply made available by the three storage alternatives. In each operation study, the proratable water supply which would have been provided by the Yakima Project without the three storage alternatives is determined. Then, the additional water supply resulting from the three storage alternatives is allocated pursuant to the thresholds. For example, if a prorated water supply of 80 percent is determined, the results for the three thresholds are to provide up to 100 percent, and 80 percent and 80 percent, respectively. If a prorated water supply of 40 percent is determined, the results are to provide up to 100 percent, 70 percent, and 50 percent respectively.

Table ES-3 illustrates these results.

**Table ES-3. Example of Proratable Water Supply Provided with the Three Storage Alternatives**

<b>Computed Proration Level Without Three Storage Alternatives</b>	<b>Integrated 100%</b>	<b>Integrated 70%</b>	<b>Integrated 50%</b>
80%	up to 100% (if available)	80%	80%
40%	up to 100% (if available)	70% (if available)	50% (if available)

Application of the 70- and 50-percent criteria results in carrying over some of the available stored water rather than fully allocating the water supply in 1 year, as is done using the integrated 100-percent operation. The analyses and conclusions in the *Yakima Alternatives Appraisal Assessment* are based on the integrated 70-percent operation scenario.

- Natural (unregulated) Scenario – Represents an unregulated Yakima Project streamflow regime, which shows flows as if there were no reservoir impoundments, diversions, or associated irrigation return flows.

Reclamation developed hydrographs for the current and integrated scenarios, and the flow regimes were compared to show the extent to which they would resemble the shape of the natural (unregulated) hydrograph.

## Findings

### Technical Viability

Based on information available at this time, the three Yakima River basin storage alternatives (Bumping Lake enlargement, Wymer dam and reservoir, and Keechelus-to-Kachess pipeline) appear to be technically viable.

These findings do not consider economic, financial, environmental, cultural, and social aspects of the three storage alternatives.

### Storage Study Goals

The dry-year irrigation water supply goal can be met by these three alternatives. The municipal water supply goal is assumed to be met. There is potential to meet the fish habitat goal on the Yakima River by constructing Wymer dam and

reservoir. However, the fish habitat goal for the Naches River cannot be met by constructing Bumping Lake enlargement.

### ***Fish Habitat***

Reclamation's RiverWare modeling of the three alternatives shows that enlarging Bumping Lake is detrimental to the shape of the Bumping and Naches River hydrographs by decreasing the quantity and shifting the timing of the spring flows. This is because the current hydrograph resembles the natural (unregulated) hydrograph. Bumping Lake enlargement also adds to the total water supply available (TWSA), which, in some years, may result in increasing the Title XII target flows at Parker. In addition, an enlarged Bumping Lake could result in further adverse environmental impacts by inundating adjacent creeks and streams.

The Wymer dam and reservoir alternative would require pumping water when there are excess flows in the Yakima River. This means that diversion to Wymer reservoir could diminish the spring freshet during the average and wet years. However, during dry years, it may be possible to operate the reservoir in a manner that benefits fish. These benefits could include pulse or flushing flows during the spring. During meetings with stakeholder groups on the three alternatives, they recommended that Reclamation explore such potential benefits further. The Wymer alternative also adds to the TWSA, which, in some years, may result in increasing the Title XII target flows at Parker.

The Keechelus-to-Kachess pipeline improves Kachess Lake storage contents in only 1 year of the 23-year period of record. This additional stored supply amounts to only about 400 acre-feet (1985). The capability to bypass up to a maximum of 210 cfs of summer releases from Keechelus Lake could provide a benefit to the fishery in the Yakima River reach from Keechelus Dam to Easton Dam.

RiverWare modeling also indicated all the integrated operation scenarios do not appear to move the river flow regime toward a natural (unregulated) hydrograph because of the need to transport a high volume of water from the upper Yakima River reservoirs (primarily Cle Elum Lake) to irrigation users in the middle Yakima River basin area. Moving this high volume of water during the summer and fall seasons results in high flows, which is contrary to the natural (unregulated) hydrograph. Therefore, the integrated 70-percent operation scenario does not eliminate or significantly diminish the current flip-flop reservoir operation.



### ***Dry-Year Irrigation Water Supply***

All three alternatives were modeled together to provide enough water storage to meet the 70-percent irrigation water supply goal. The 23-year average TWSA is 3,220,000 acre-feet with the integrated 70-percent operation, as compared to the current operation TWSA of 2,850,000 acre-feet. With additional basin storage alternatives and an operating plan that uses the additional storage capacity primarily as carryover, the 23-year average TWSA could be increased by 370,000 acre-feet.

One-year droughts which follow 2 or more wet years could have a 30-percent improvement. This is demonstrated by drought year 2001, for which the modeled current operation provided a 41 percent proratable water supply, but the integrated 70-percent operation provided a 70-percent proratable supply.

The operations modeling shows the irrigation water supply conditions are improved in the prolonged 3-year dry period of 1992-1994. The three in-basin storage alternatives increased the proratable water supply in 1992 and 1993 to not less than 70 percent. The 1994 proratable water supply was increased to 66 percent; 4 percentage points below the 70-percent threshold. It is estimated the 4-percent difference equals about 50,000 acre-feet.

### ***Municipal Water Supply***

In the *Black Rock Appraisal Assessment*, Reclamation had assumed the future surface water need of 10,000 acre-feet for the cities of Cle Elum and Yakima (the only current municipal surface water users) could be met with any new storage facilities. After reviewing the water supply estimates in the January 2003 *Watershed Management Plan* (Yakima River Basin Watershed Planning Unit and Tri-County Water Resources Agency, 2003), Reclamation concluded if the results of ongoing groundwater investigations show there is a connectivity of surface and groundwater, any increase in groundwater use by municipalities and domestic users may require mitigation by surface water supplies. If this were to occur, the future municipal and domestic water needs could be as much as 82,000 acre-feet by year 2050.

As information regarding the surface and groundwater connectivity becomes available, Reclamation will work with local and state entities to develop a strategy, including hydrologic modeling, to accommodate the volume and priority of municipal and domestic water supply demands.

### Conclusions

Reclamation will not perform further analysis on the Bumping Lake enlargement and Keechelus-to-Kachess pipeline in the Plan Formulation Phase. However, Reclamation will retain the Wymer dam and reservoir alternative for further investigation in the Plan Formulation Phase.

Reclamation, through its hydrologic analysis, has determined that storing more water in an enlarged Bumping Lake would cause the spring flows in the Bumping River to decrease in volume and shift in timing. This shift in flow quantity and timing carries through the Bumping River into the lower Naches River. Since the Bumping River hydrograph currently resembles the natural (unregulated) hydrograph, this change in the hydrograph is unacceptable. The extra storage in Bumping Lake enlargement does help meet the irrigation water supply goal in all years except the last year of a 3-year drought. Reclamation is assuming that the municipal water supply goal will be met with this alternative. Even though the irrigation water supply goal could be partially met with this alternative, the negative impact to the hydrograph and the potential environmental impacts identified in previous studies indicate that this alternative should not be carried forward.

Reclamation, through its hydrologic analysis, has determined that the Keechelus-to-Kachess pipeline provides neither irrigation nor fish habitat benefits, as it only provides extra storage in 1 year out of the 23-year period of record and does not move the flow regime toward the natural (unregulated) hydrograph. Reclamation is assuming that this alternative will not help meet the municipal water supply goal. Therefore, Reclamation will not forward the Keechelus-to-Kachess pipeline alternative into the Plan Formulation Phase.

Reclamation's current analysis does not show if the Wymer dam alternative impacts the hydrograph, either in a positive or negative manner. Reclamation is assuming the municipal water supply goal may be met with this alternative. Although Wymer does not appear to meet the Storage Study goals by itself, it does meet the purpose and need, and it is technically viable. Because of stakeholder interest and its potential for providing fish habitat benefits, Wymer will be analyzed further in the Plan Formulation Phase.

Further investigations of Wymer dam and reservoir could include various operation scenarios and the potential for a Columbia River water supply. Field data at the Wymer damsite appears sufficient for plan formulation.